User Manual

Allen-Bradley

PowerMonitor Wireless 250 Monitor

Catalog Numbers 1425

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Notes:

The information in this manual applies to the PowerMonitor W250 wireless power monitor.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley® distributor or Rockwell Automation sales representative.

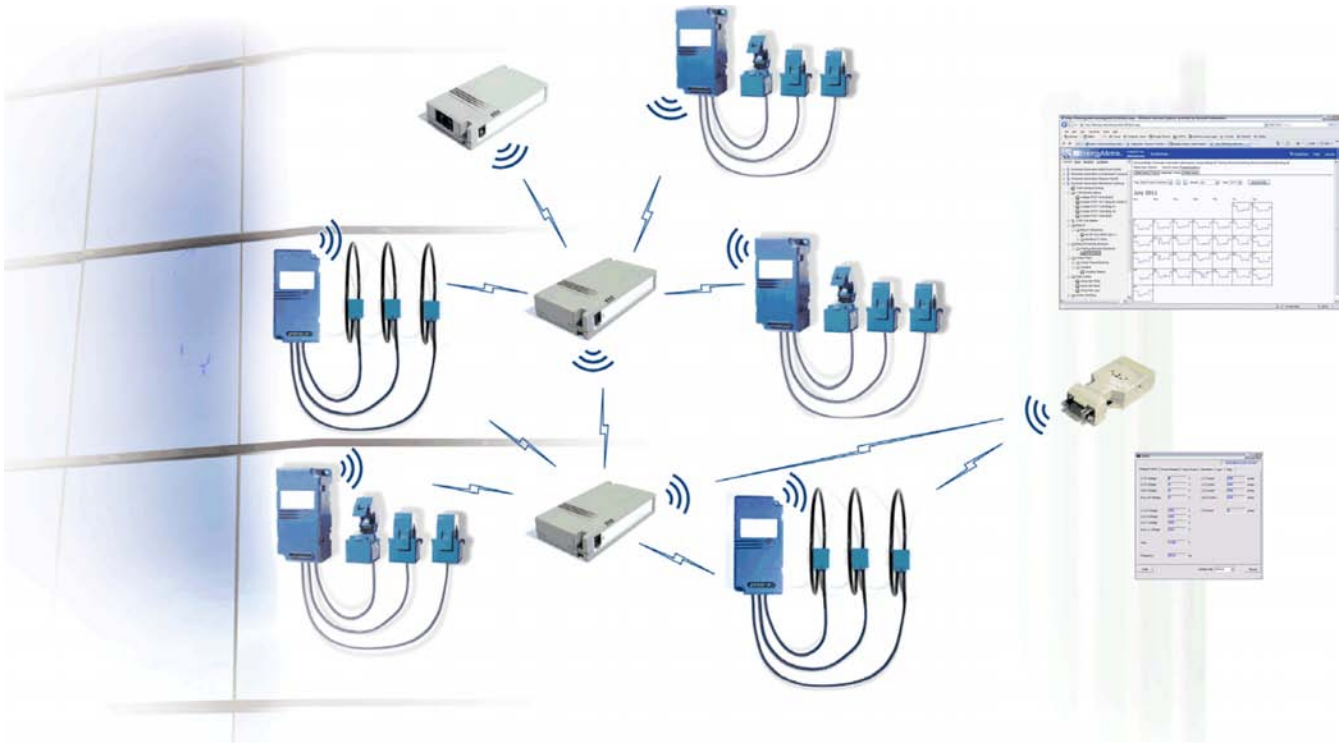
Notes:

PowerMonitor W250 Unit Overview

About the PowerMonitor W250 Unit

The PowerMonitor W250 product family provides a cost-effective, wireless sub-metering solution for use with RSPower™, version 5.0 or later, data visualization and RSEnergyMetrix™, version 1.9 or later, energy monitoring, load profiling, and reporting software. The PowerMonitor W250 family includes a selection of power monitors, receivers, and routers that communicate wirelessly in a mesh arrangement designed for robust, reliable energy data collection.

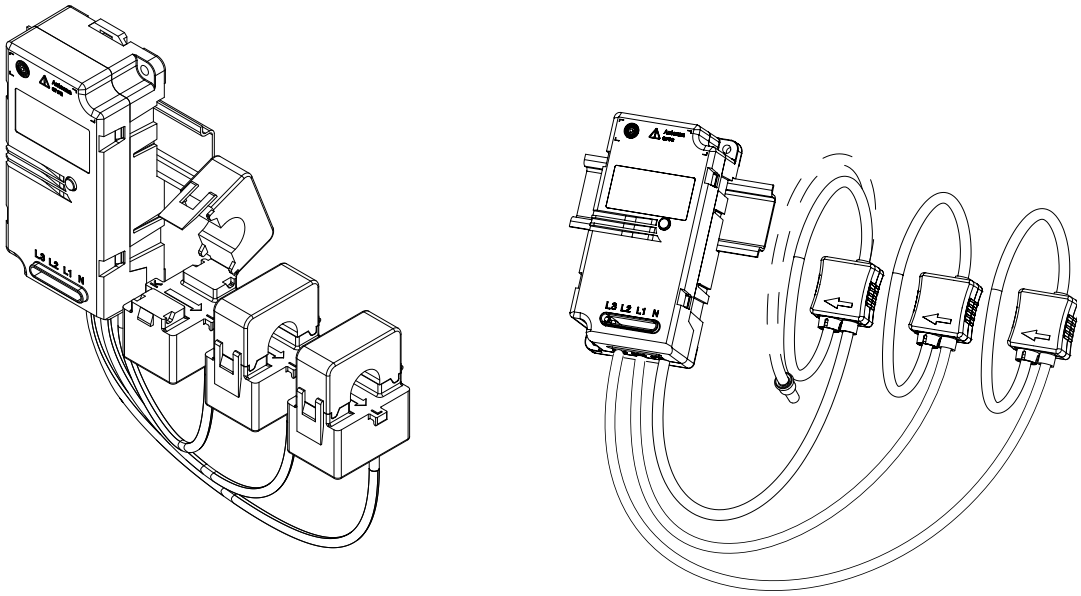
Figure 1 - Wireless PowerMonitor W250 System Overview



The PowerMonitor W250 unit consists of three main parts:

- Wireless power monitor: The PowerMonitor W250 unit is a sub-meter that measures and calculates several electrical parameters. The unit is equipped with pre-wired split core current transformers or Rogowski coils and embedded wireless data transmission capabilities.

Figure 2 - Wireless Power Monitor

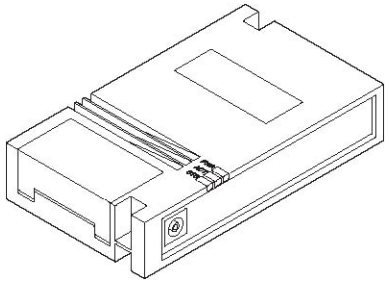


- Wireless PC Receiver: The receiver is a standalone gateway that manages the wireless network and collects data periodically sent by PowerMonitor W250 units. The receiver transmits data through its serial port to the data logging system for analysis. An optional, user-provided serial to Ethernet converter connects the receiver to your local area network.

Figure 3 - Wireless PC Receiver

- Wireless router: The router is a repeater that extends the distance of the wireless transmission range and can provide multiple signal paths between the PowerMonitor W250 unit and the receiver when needed.

Figure 4 - Wireless Router



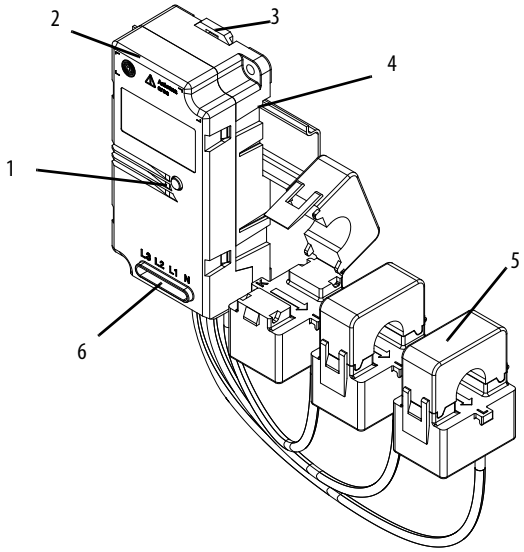
PowerMonitor W250 Unit

The PowerMonitor W250 unit is a 3-phase electric meter with wireless communication. The following illustration highlights its major components.

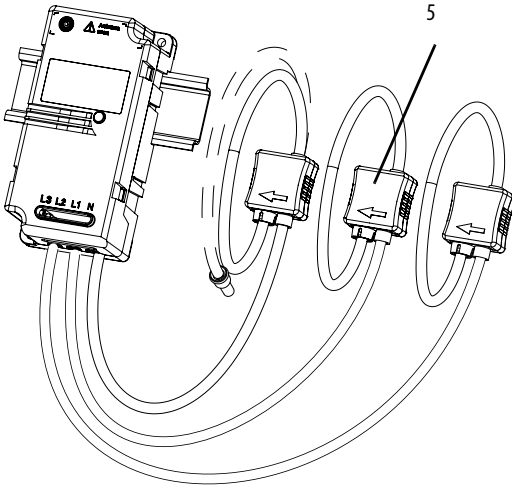
Table 1 - PowerMonitor W250 Major Components

Item	Description
1.	Status indicator - Operation of the status indicator is described on page 31.
2.	Antenna location
3.	DIN-rail mounting fixture
4.	Product identification label Identification
5.	Current transformer (CT) or Rogowski coil
6.	Voltage input terminals

Figure 5 - PowerMonitor W250 Unit



PowerMonitor W250 Unit with Current Transformers (CT)



PowerMonitor W250 Unit with Rogowski Coils

PowerMonitor W250 Data Overview

The PowerMonitor W250 unit sends data to the wireless receiver periodically. The meter data is split into three sections:

- Cumulative Energy Consumption Metering Data: The power monitor transmits accumulated real, reactive, and apparent energy, per-phase and total, once per minute. The transmission is accompanied with the time stamp of the most recent reading.
- Interval Metering Data: The power monitor sends, at the end of the user-selected interval, a time-stamped record of the following data: real, reactive, and apparent energy per phase and sum; minimum voltage per phase and maximum current per phase during recording interval; frequency.
- Node Identification, Configuration, and Status: Node configuration and version; recording interval time setup, command and status word.

PowerMonitor W250 Model Description

The following table lists the available models of the PowerMonitor W250 unit.

Table 2 - Model Description

Cat. No.	Description	Current Rating (A)	Max Voltage(1)	Delta/Wye	Current Sensing	Model Code
1425-D1002-MOD	PowerMonitor Wireless, 100A, 300V Delta	100	300	Delta, 3 W	CT	111
1425-D1002-MOD-480	PowerMonitor Wireless, 100A, 480V Delta	100	480	Delta, 3 W	Rogowski Coil	111
1425-W1003-MOD	PowerMonitor Wireless, 100A, 300V Wye	100	300	Wye, 4 W	CT	000
1425-D2002-MOD	PowerMonitor Wireless, 200A, 300V Delta	200	300	Delta, 3 W	CT	111
1425-W2003-MOD	PowerMonitor Wireless, 200A, 300V Wye	200	300	Wye, 4 W	CT	000
1425-D5002-MOD	PowerMonitor Wireless, 500A, 300V Delta	500	300	Delta, 3 W	CT	111
1425-D5002-MOD-480	PowerMonitor Wireless, 500A, 480V Delta	500	480	Delta, 3 W	Rogowski Coil	111
1425-W5003-MOD	PowerMonitor Wireless, 500A, 300V Wye	500	300	Wye, 4 W	CT	000
1425-D10002-MOD	PowerMonitor Wireless, 1000A, 300V Delta	1000	300	Delta, 3 W	CT	111
1425-W10003-MOD	PowerMonitor Wireless, 1000A, 300V Wye	1000	300	Wye, 4 W	CT	000
1425-D20002-MOD	PowerMonitor Wireless, 2000A, 300V Delta	2000	300	Delta, 3 W	CT	111
1425-D20002-MOD-480	PowerMonitor Wireless, 2000A, 480V Delta	2000	480	Delta, 3 W	Rogowski Coil	111
1425-W20003-MOD	PowerMonitor Wireless, 2000A, 300V Wye	2000	300	Wye, 4 W	CT	000

(1) Maximum voltage on sensing terminals must not exceed the following:
a.300V Delta, 3 W: 300V AC line-to-line maximum
b.300V Wye, 4 W: 300V AC line-to-neutral maximum
c.480V Delta, 3 W: 520V AC line-to-line, 300V AC line-to-neutral maximum

Wireless Mesh Network Components

The PowerMonitor W250 unit communicates by using a wireless mesh network, capable of forming multiple paths in order to increase the robustness of the network and respond to dynamic radio environments that may obstruct radio transmission. In general, mesh network nodes are positioned at the point of sensing and control to eliminate or minimize wiring. The PC Receiver is the gateway between the wireless mesh network and RSEnergyMetrix software or other client application. The wireless router extends the range of mesh network nodes to accommodate long distances between PowerMonitor W250 units, overcome physical barriers, and provide for multiple routing.

Wireless PC Receiver Overview

The wireless PC Receiver acts as a gateway that manages the wireless communication network, and collects data from, and transmits control commands to, the PowerMonitor W250 units that are members of the network.

Table 3 - Wireless PC Receiver and Accessories

Cat. No.	Description
1425-GAT10	PowerMonitor Wireless PC Receiver, 10 Nodes
1425-GAT100	PowerMonitor Wireless PC Receiver, 100 Nodes
1425-GAT200	PowerMonitor Wireless PC Receiver, 200 Nodes
1425-ADR1	PowerMonitor Adapter, US
1425-ADR2	PowerMonitor Adapter, EMEA
1425-ADR3	PowerMonitor Adapter, UK

Physical features of the wireless PC Receiver unit are listed below.

Table 4 - PC Receiver Features

Item	Description
1.	Status indicators
2.	Power supply connector 6…30V DC
3.	RS-232/485 DB-9F connector
4.	Internal push button (accessible with a < 1 mm rod, such as an unbent paper clip)

Figure 6 - PC Receiver

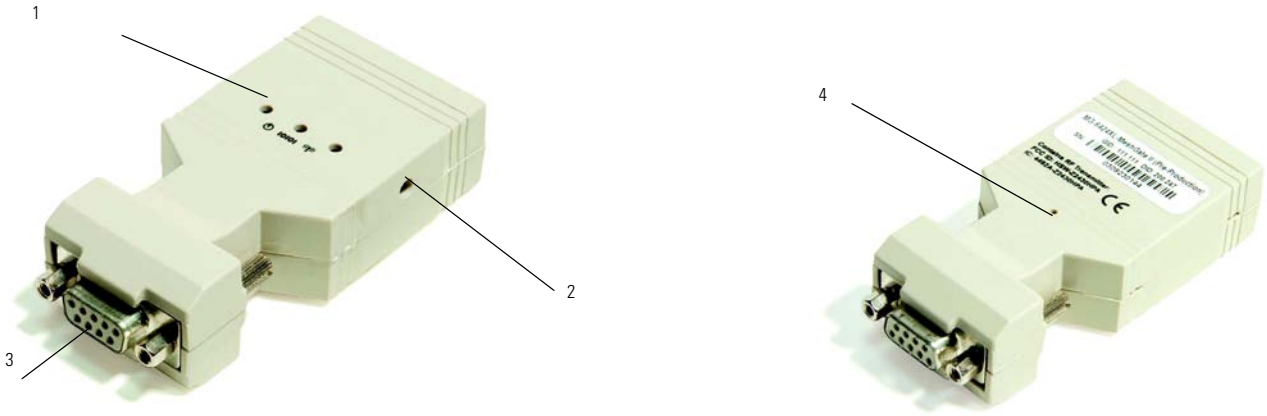


Table 5 - PC Receiver Status Indicators

Indicator	Position	Status	Description
Power	Left	Green ON	Power OK
		OFF	Power has been removed
Communication	Middle	Green ON	Modbus mode
		Amber ON	Standard (MASC) mode for Meshscape Network Monitor or Meshscape programmer use
		Red ON	Programming in progress
RF activity	Right	Green ON	Initialization, PC Receiver not operating
		Flashing Green	RF activity

Wireless Router Description

The Wireless Router extends the range of the mesh network to accommodate longer distances between nodes, overcome physical barriers, and provide for multiple signal routing.

Table 6 - Wireless Router and Accessories

Cat. No.	Description
1425-NOD	Wireless Power Monitor Router
1425-ADR1	PowerMonitor Router Adapter, US
1425-ADR2	PowerMonitor Router Adapter, EMEA
1425-ADR3	PowerMonitor Router Adapter, UK

Table 7 - Wireless Router Features

Item	Description
1	Status indicators (see Table 8)
2	Power supply connector 6…30V DC
3	Connector panel access cover (ON/OFF switch)

Figure 7 - Wireless Router

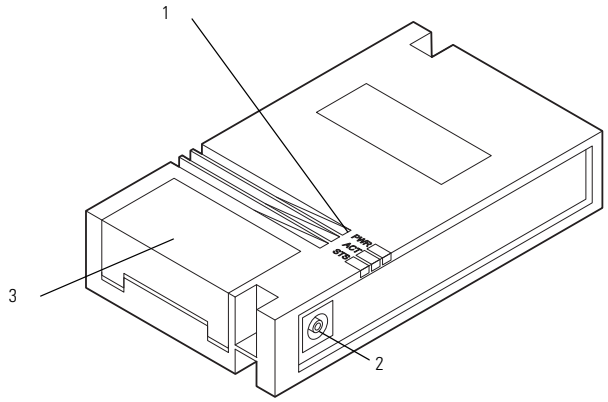


Table 8 - Wireless Router Status Indicators

Indicator	Status	Description
PWR	ON	Power ON.
	OFF	No power.
RF Activity	Flashing	Router detects RF activity. The RF activity indicator will flash when detecting valid packets (packets destined for device) and may also flash when detecting invalid packets (packets destined for other devices) or environmental noise. Only valid packets are processed by the device.
	OFF	No RF activity detected.
STS	ON Solid Green	Device has established two or more connections with other devices.
	Blinking	The router has established a single connection; additional routers may be needed to increase robustness.
	OFF	The router is not on the network: additional routers are needed for this device to connect to the network.

Wireless Network Description

The PowerMonitor W250 unit communicates with the PC Receiver node by using a self-configuring, wireless mesh network. Node IDs (addresses) are programmed at the factory and usually do not need to be changed. Please contact Rockwell Automation for assistance if you need to change the node ID of a device.

In a wireless mesh network, messages may be received and retransmitted by several devices, depending on the design and layout of the network. Each wireless retransmission between the power monitor and the PC Receiver through one or more Routers is called a 'hop'. When operating, the network automatically selects the path with the least hops through routers if it is available.

Strategies to design the wireless network to increase robustness and overcome challenges presented by the environment are discussed in Chapter 2, Hardware Installation.

Each PowerMonitor W250 unit and the PC Receiver are equipped with a radio module. The PC Receiver buffers in its RAM the metering values received from the power monitors. The measurement values of the PowerMonitor W250 unit are buffered in the PC Receiver's RAM.

When a Modbus master station reads data from PowerMonitor W250 registers, it reads the buffered values from the PC Receiver.

However, when a Modbus master station transmits a command to a power monitor, the command is forwarded to the power monitor. A delay of 2...4 minutes may occur until the PC Receiver transmits the response message.

Notes:

Hardware Installation

This chapter describes how to install the hardware to set up the Wireless Mesh Sub-meter Network.

Safety Considerations

ATTENTION: Only qualified personnel, following accepted safety procedures, should install, wire and service the PowerMonitor W250 unit and its associated components. Before beginning any work, disconnect all sources of power and verify that they are de-energized and locked out. Failure to follow these instructions may result in personal injury or death, property damage, or economic loss.

This equipment is designed to be installed in an enclosure with access restricted to qualified personnel. Installation is to be performed in accordance with all applicable codes, regulations, laws, and standards.

- The equipment must be installed in an appropriate enclosure to provide protection to personnel and is suitable for the physical installation environment.
- Do not remove or change any part of the product, or cut any cables, as doing so may damage it or other equipment or cause serious injury or death.
- If the equipment or any part of it is damaged, do not install it. Remove and replace any damaged equipment.

Before You Begin

- Check carefully that the PowerMonitor W250 model received is appropriate for the system to be monitored. Otherwise, wrong or incomplete data may be sent to the wireless PC Receiver.
- Carefully read this manual and observe any notes, cautions, or warnings.

Network Deployment Recommendations

Prior to defining your network and the elements location, read the following information.

IMPORTANT We recommend you apply power to the Wireless PC Receiver before applying power to the PowerMonitor W250 unit or Router nodes.

ATTENTION: All devices are designed for indoor use only.

Planning Your Installation

Follow this information before installing your PowerMonitor W250 unit.

Building Audit

Mesh devices all communicate via wireless radio frequencies and are influenced by several factors (electrical wires, metal objects, heavy concrete walls, direction of installed devices, and so on).

Consider the following items in network configuration:

- Number of floors, layout
- Network topology - dense versus spread out/serial
- Type of building material
- Power availability for routers and receivers not attached to meters
- Any known obstacles or RF interferences (for example, heating pipes, electrical room)
- 'Bridge' router placement
- Detect other 2.4 GHz interference

Walls and Floors

Inside a building, radio waves deflect on walls and other objects create interference.

When the PowerMonitor W250 unit or other system components are mounted on a wall or where the RF signal travels through a wall or other construction, be aware of the materials used in the construction (both sides). Note that certain materials will reduce the signal strength and maximum distance between nodes.

Usually, floors are most difficult for radio frequency signals to penetrate due to materials used (for example, concrete, cement, and tiles). So, consider placing routers in stairways and other open spaces available between floors.

Effect of Different Materials on Signal Strength and Maximum Node-to-node Distance

Glass, sheet rock, and wood have the least impact to the RF signal.

Steel-reinforced concrete, brick walls, and corrugated steel surfaces are much more difficult for the RF signal to penetrate. The maximum node-to-node distance could be cut in half compared to the unobstructed maximum distance. In any case, the maximum distance between two nodes depends on the geometry of the signal path and the number, thickness, and composition of any obstructions.

Metal blocks virtually all radio communication. RF transmission through metal is facilitated by openings (slits, holes, and gaps) in the metal.

Network Topologies

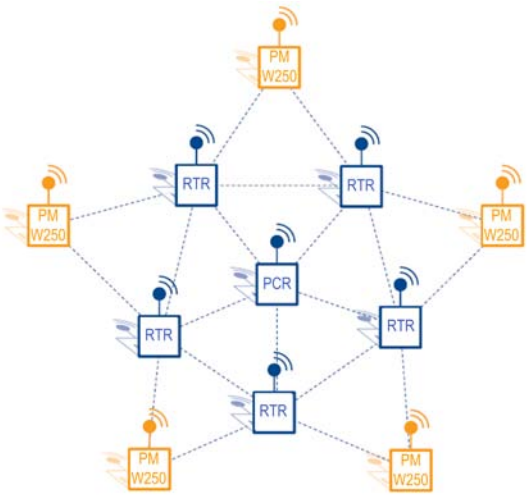
The robustness and reliability of communication between PowerMonitor W250 devices and RSEnergyMetrix software or other clients depends primarily on network RF signal strength. In turn, RF signal strength is dependent upon the topology of the network. In general, a mesh network topology that provides parallel links between devices provides better RF signal strength resulting in more robust communication. Linear topologies that offer only a single path from device to client can create bottlenecks that reduce effective RF signal strength and adversely impact communication robustness. You may add more routers to a network topology to accommodate longer distances or add parallel routes through the network in areas that present a challenging environment.

Preferred Network Topology

An ideal network topology is 'Star-Mesh', where all nodes are evenly distributed from the PC Receiver and offer multiple, parallel communication links.

In such a configuration, all devices can communicate with multiple nodes, so that if one router fails or if a radio link experiences interference, the network will reconfigure itself through the remaining nodes. Having multiple routes to the gateway will also improve the estimated sampling rate.

Figure 8 - Star Mesh Topology (Best)



Alternative Topologies

The network topologies shown below are not as robust as the Star Mesh topology. However, for simple installations within an environment that is favorable, these topologies may provide acceptable network performance.

Figure 9 - Linear Topology (Good)

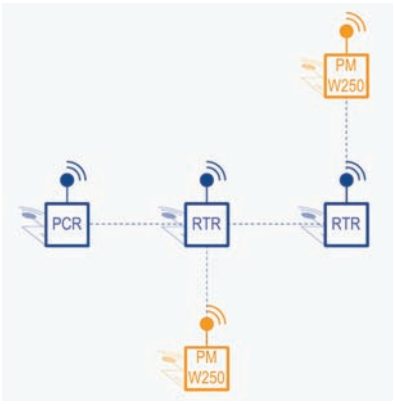
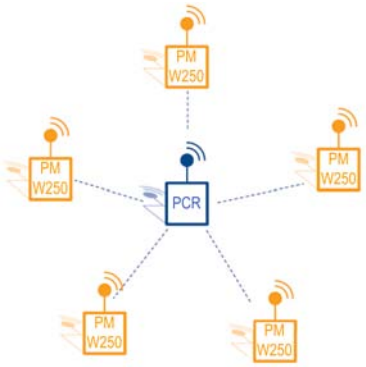


Figure 10 - Star Topology (Better)

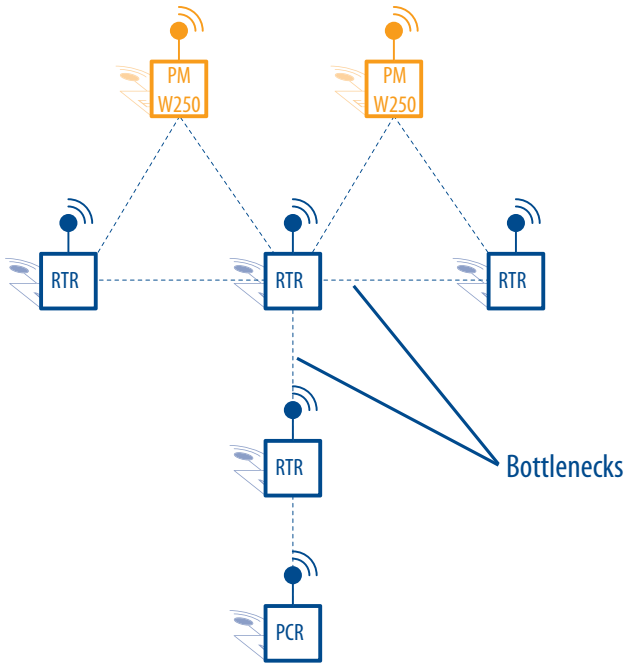


Constricted Topology: Not Recommended

In some cases, PowerMonitor W250 devices might be located far away from the PC Receiver and all data from the network has to travel over a single path. Such a situation creates bottlenecks and increases the risk of losing data packets.

We recommend avoiding such topologies by adding additional routers to provide parallel links to the PC Receiver.

Figure 11 - Constricted Topology



PC Receiver Location and Connection

Consider these suggestions when locating your PC Receiver:

- When possible, locate the PC Receiver near the geographical center of the RF network.
- It may be helpful to have a notebook personal computer for startup, diagnostics, and troubleshooting.

Follow these steps to connect the PC Receiver.

1. Apply power to the PC Receiver by plugging in the DC power supply adapter.

   We recommend that you apply power to the PC Receiver prior to applying power to any PowerMonitor W250 devices.

2. Connect the PC Receiver's data port (DB-9F connector) to the serial port of a host computer, a serial to Ethernet converter, or similar device.

   TIP To connect to a USB port, the Allen-Bradley 9300-USBS USB to serial adapter (or equivalent) is recommended. Please contact your local Rockwell Automation representative for more information.

Figure 12 - Connect the PC Receiver Data Port to the Personal Computer

Router Location and Connection

Router location and orientation is important. The router is designed to be mounted horizontally. The radio antenna, on the router, transmits in a horizontal, circular pattern when the signal path is not obstructed. The following guidelines help you locate router devices to attain acceptable radio signal strength and system performance:

- It is best to mount routers in a horizontal orientation. It is less desirable, but acceptable, to orient one router horizontally and another vertically. It is not recommended to orient all routers vertically, unless doing so intentionally to route the radio signal vertically through a stairway, chase, or elevator shaft.
- Mount power monitors in a vertical orientation.
- Avoid locating a router directly underneath a PowerMonitor W250 device. The internal electronic circuitry in the power monitor may obstruct the radio signal.
- Avoid installing routers directly onto a horizontal metal surface. Use spacers to create a free space of 3...5 mm between the router and the metal surface.
- When the radio signal must penetrate an obstruction such as a concrete wall, locate network devices (routers and/or power monitors) on opposite sides of the wall to create a short, direct signal path. Signal loss may occur if a long path exists through an obstruction.

  See Figure 13.

Figure 13 - Router Orientation Guidelines

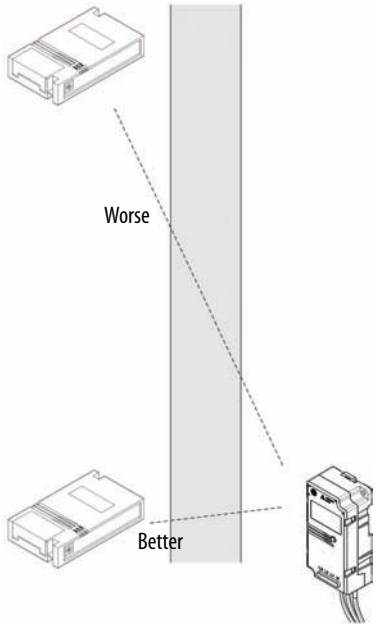
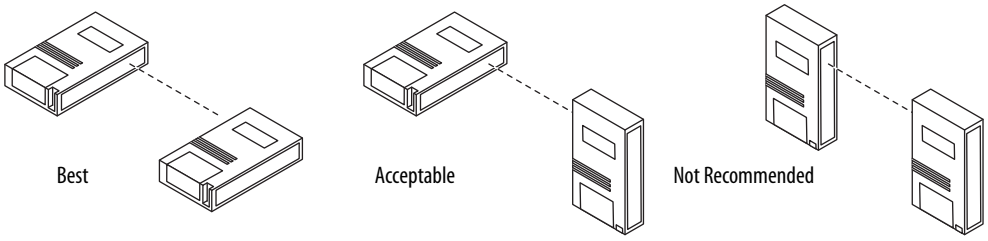
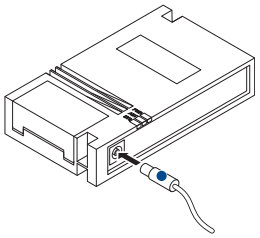


Figure 14 - Relative Orientation of Routers



Apply power to the Router by plugging in the power supply adapter.

Figure 15 - Connect the Router Power Supply



PowerMonitor W250 Mounting

WARNING: Disconnect and lock out all sources of electric power to the location in which the PowerMonitor W250 unit is to be installed and the circuit to which it will be connected.

WARNING: The PowerMonitor W250 unit must be installed vertically as shown in Figure 16.

PowerMonitor W250 Location

Be aware of the location and orientation of the PowerMonitor W250 unit's internal antenna when selecting an installation location. The internal antenna faces the front of the unit, in the upper left corner. The following sections provide detailed recommendations for various installation conditions.

Basic Guidelines

To obtain the best effectiveness of the network, apply the following recommendations:

- Avoid installing the PowerMonitor W250 unit in front of or close to metallic parts. Doing so may reduce the efficiency of the embedded antenna.
- Avoid installing the PowerMonitor W250 unit near sources of electromagnetic induction.
- Refer to the illustrated layout for guidelines to optimize the orientation of the antenna.

Inside a Metallic Cabinet

Typical electrical enclosures or cabinets are never completely sealed due to openings and gaps. This permits a certain level of RF communication, although it may be highly attenuated.

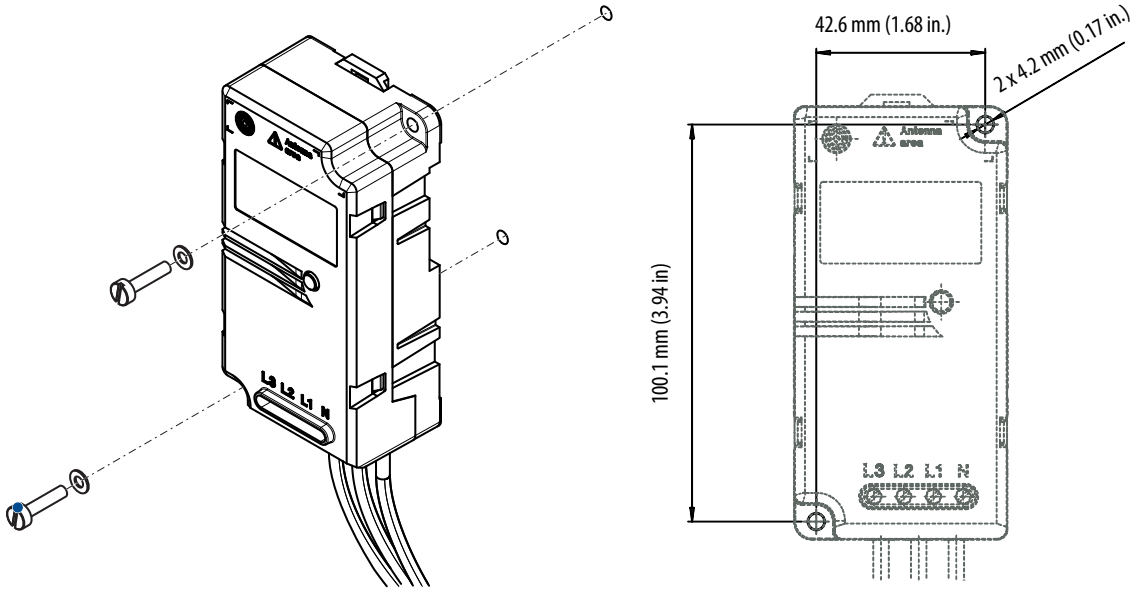
When the PowerMonitor W250 unit must be installed inside a metal enclosure, to get the best effectiveness, the following guidelines apply:

- Avoid installing the PowerMonitor W250 unit in the center of the cabinet where most electrical cables are located.
- Install the PowerMonitor W250 on one side, close to a door gap or opening if any exist.
- If there are openings for cable routing in the top, bottom, or sides of the enclosure, locate the PowerMonitor W250 unit close to these openings.
- Install a Router within 1 meter of the enclosure to counteract the attenuation of the RF signal.

Wall and Panel Mounting

1. Prepare the mounting holes to suit.
2. Secure the PowerMonitor W250 unit to the wall or the panel with 4 mm (6-32) screws.

Figure 16 - Wall or Panel Mounting

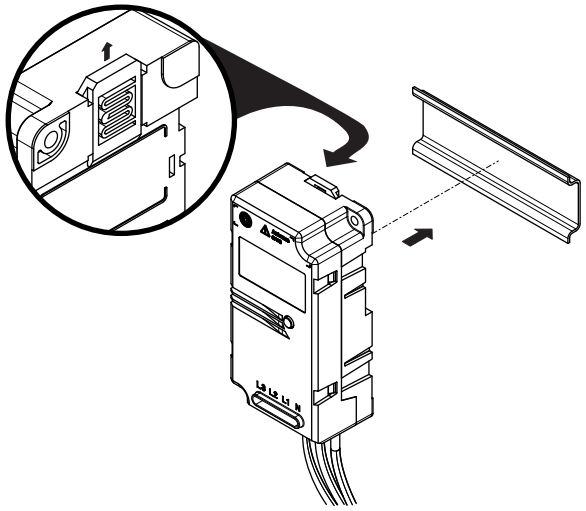


IMPORTANT	Tighten mounting screws snugly. Maximum fastening torque is 2.8 N•m (2 lb•ft).

DIN Rail Mounting

1. Clip the PowerMonitor W250 unit onto the DIN rail.
2. Pull up the top clip (see detail) to remove the PowerMonitor W250 unit from the DIN rail.

Figure 17 - DIN Rail Mounting

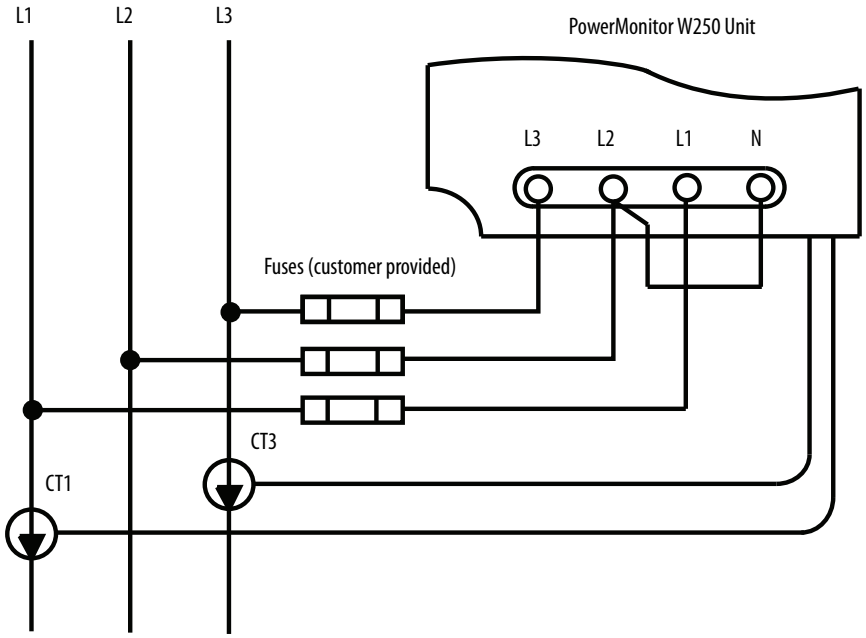


PowerMonitor W250 Unit Wiring

This section shows the types of wiring and how to connect the PowerMonitor W250 unit.

Wiring Diagrams

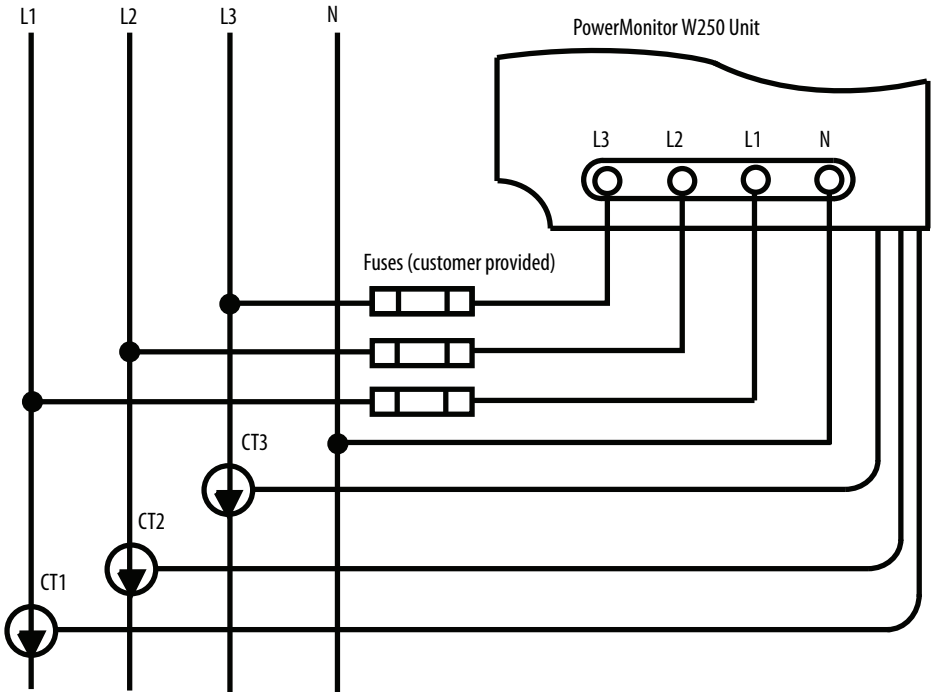
Figure 18 - Delta, 3-wire, 1425-D*xxx*(*x*)3-M0D Unit



Maximum voltage V(L1-L2) and V(L2-L3) is 300V AC rms. Not for use on 400V AC or 480V AC circuits.

WARNING: Do not connect the N terminal to earth ground.

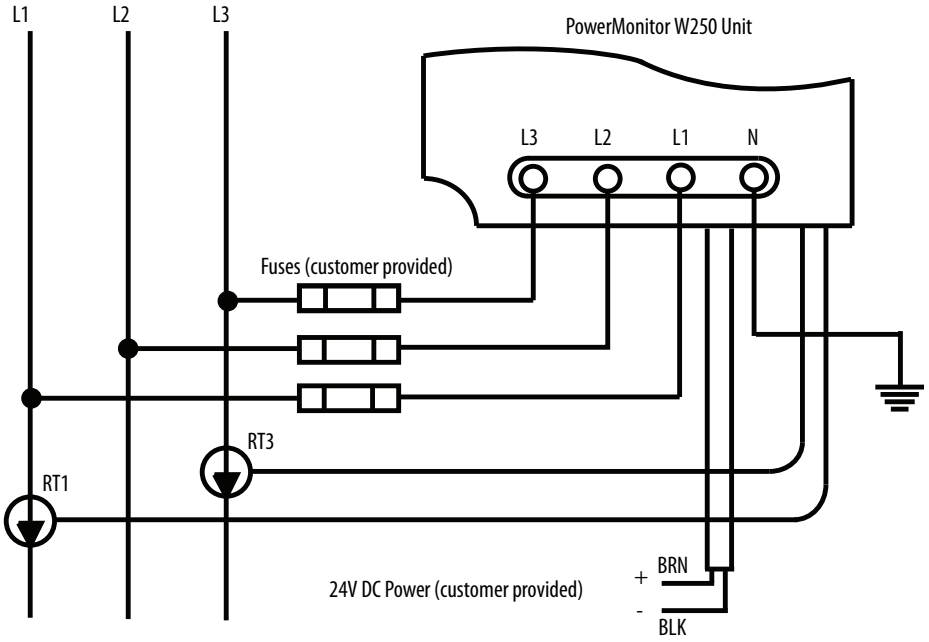
Figure 19 - Wye, 4-wire, 1425-W*xxx*(*x*)3-M0D Unit



Maximum voltage V(L1-N), V(L2-N) and V(L3-N) is 300V AC rms.

WARNING: Do not connect the N terminal to earth ground.

Figure 20 - Delta, 3-wire, 480V AC, 1425-D*xxx*(*x*)3-MOD-480 Unit



Maximum voltage V(L1-L2) and V(L2-L3) is 520V AC rms; V(L1-N), V(L2-N) and V(L3-N) is 300V AC rms. Designed for use on up to 520V AC circuits. This device is Isolation Class 1. The green/yellow wire must be connected to earth ground. The 24V DC power supply must be NEC Class 2. An example of a suitable power supply is the Allen-Bradley 1606-XLP15E, 15-watt, 24 V DC with a single-phase AC input.

TIP Note that the black 24V DC - wire is internally connected to the green/yellow ground wire.

Current Transformers

ATTENTION: Disconnect and lock out all sources of electric power to the location in which the PowerMonitor W250 wire is to be installed and the circuit to which it will be connected.

The current sensors are intended to be used only on insulated cable. Do not apply to uninsulated cable or bus bar. The current sensors are intended for no more than 50 open/close operations. Do not attempt to use them as a clamp-on meter.

The current transformer mating surfaces must be kept free of particles and other contamination, otherwise accuracy may be compromised.

1. Observe the correct phase assignment of current transformers with respect to the voltage phase connections.

   Refer to the wiring diagram for the applicable PowerMonitor W250 model. If phase assignment and polarity are not correctly observed, the PowerMonitor W250 unit produces incorrect energy data.

2. Verify that the arrow (3) points in the direction of current flow from the supply (line) to the load.

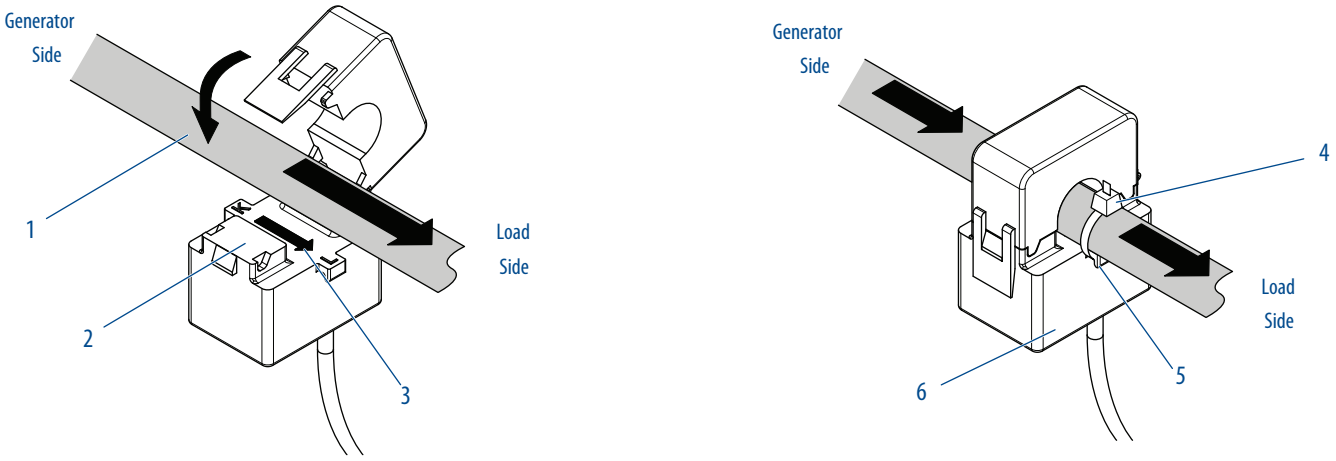
   In the illustration, the label (6) is facing the load.

3. Close the Current Transformer around the cable (1).

   Be sure the clip is snapped shut.

4. Use the mounting clip (5) and a cable tie (4) to attach the Current Transformer to the cable.

Figure 21 - Current Transformer Mounting



Rogowski Coil

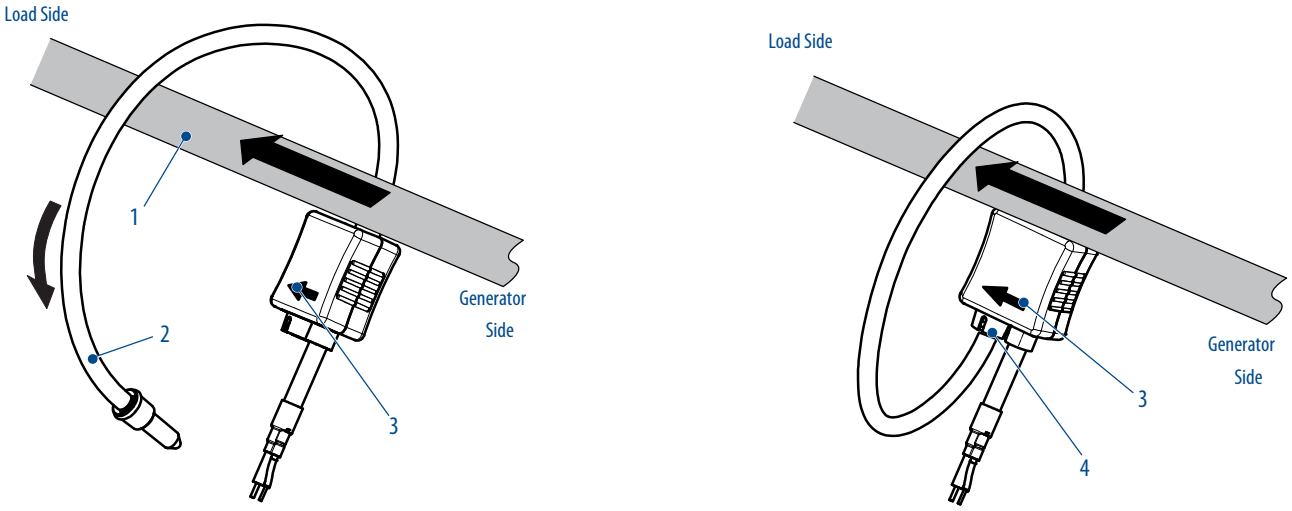
ATTENTION: When installing a Rogowski coil, take care not to kink, pinch, twist, or sharply bend the coil. Applying such mechanical stress to the coil may reduce the accuracy of the PowerMonitor W250.

1. Observe the correct phase assignment of Rogowski coils with respect to the voltage phase connections.

   Refer to the wiring diagram for the applicable PowerMonitor W250 model. If phase assignment and polarity are not correctly observed, the PowerMonitor W250 unit will produce incorrect energy data.
2. Verify that the arrow (3) points in the direction of current flow from the supply (line) to the load.
3. Close the Rogowski (2) coil around the cable (1).

   Be sure that the coil is well locked (fully inserted until a click is heard).

Figure 22 - Rogowski Coil Mounting



IMPORTANT The arrow indicating the current direction must be inside the loop (3) when closed as shown.

The Rogowski coil can be oriented freely around the cable/conductor. It does not need to be attached. The position of the conductor within the Rogowski coil does not affect the accuracy more than 0.5%.

Voltage Input Connection

ATTENTION: A set of fuses or a circuit breaker must be installed between the main supply and the PowerMonitor W250 unit for line protection. The protection device must be installed near the PowerMonitor W250 device, be easily accessible, and be identified as the circuit protection for the PowerMonitor W250 unit.

Use fuses or a circuit breaker with the following characteristics.

Table 9 - Fuse and Circuit Breaker Characteristics

Protection Range (A)	Wiring (mm^2)/AWG	Single Fault Condition Max Trip Time (ms)
6.3	1 /18	30 ms
10	1.5 /16	30 ms
16	2.5 /14	30 ms

WARNING: Disconnect and lock out all sources of electric power to the location in which the PowerMonitor W250 unit is to be installed and the circuit to which it will be connected.

Connect voltage sensing wiring according to the applicable wiring diagram for the model. Wiring terminals will accept a single 2.5 mm^2 (14 AWG) or two 1 mm^2 (18 AWG) conductors. Use wire with a minimum 65° C rating.

Please refer to Wiring Diagrams on page 24.

For PowerMonitor W250 catalog numbers ending in -480, connect the two power supply wires to a 24V DC power supply you provide:

- Brown = +24V DC
- Black = V DC common

The power supply output must be in the range of 21.6...26.4V DC and should not supply power to any devices except for other nearby PowerMonitor W250 units.

Connect the green/yellow wire to a low impedance earth ground connection.

Status Indicator Description

The PowerMonitor W250 status indicator indicates the unit status as follows.

Figure 23 - PowerMonitor W250 Status Indicator

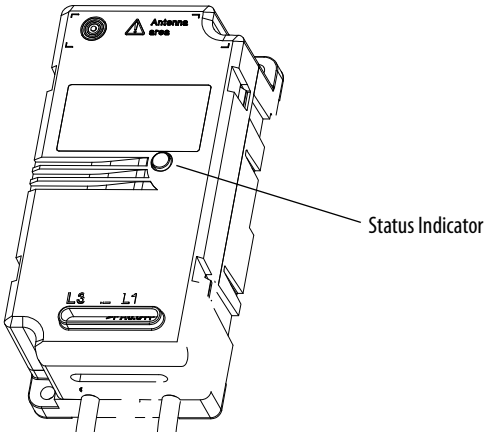


Table 10 - Status Indicator Description

Indicator Status	Description
1 blink, wait 2 seconds	Normal operation and direct serial communication mode from firmware revision 2.02.
2 blinks, wait 1 second	Radio module communication error: PowerMonitor W250 unit is unable to send data.
3 blinks, wait 1 second	Frequency out of range of 45. . .66 Hz.
4 blinks, wait 1 second	Communication and frequency error together.
5 blinks, wait 1 second	Device Error: Indicates a firmware checksum error. To recover, try a reset-meter command followed by an OFF/ON sequence. If this does not reset this error, the calibration memory is corrupt and the device needs to be returned to Rockwell Automation for repair.
6 blinks, wait 1 second	Direct serial communication mode (factory use only) until firmware revision 2.01.
7 blinks, wait 1 second	Internal hardware failure. Please contact Rockwell Automation for service.

Network Commissioning

This section describes the module identification and PC Receiver connection.

Module Identification

Figure 24 - Label

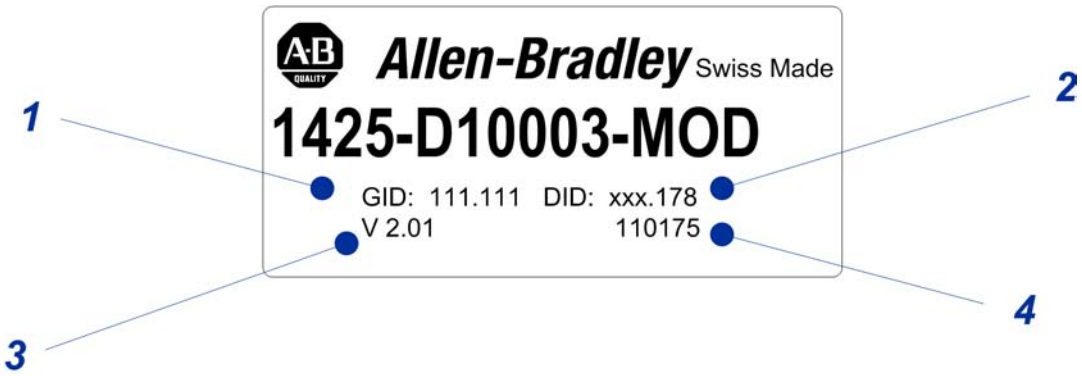


Table 11 - Label Information

Item	Description
1	Group ID
2	Device ID
3	Firmware revision
4	Manufacture date code

Each module has two identification numbers: Group ID and Device ID, each defined by 2 bytes.

The Group ID and Device ID are printed on labels on the following:

- PowerMonitor W250 unit front side
- Router or PC Receiver rear side

TIP All modules, including the PC Receiver, must be set with the same Group ID to communicate together on the same network. All parts are delivered from factory with default GID: 111.111.

The devices are addressed at the factory, as shown in the following table.

Table 12 - Device Addresses

Device Type	Device	High byte	Low Byte (Modbus address)
End Node Devices (high byte 1…159)	PowerMonitor W250	1…30	1…216
	Reserved	41…159	100 …216
Router Devices (high byte 160 …255, except 248 & 249)	Reserved	160…209	1…216
	Router	210…219, 240…247	217 …246
PC Receiver	PC Receiver	160 …255 (except 248 & 249)	247

IMPORTANT The device ID low byte defines the Modbus network address for the module. The Modbus address of each device on the network must be unique.

The PC Receiver's Device ID high byte determines the maximum number of devices supported in the network.

Table 13 - Number of Devices

PC Receiver ID High Byte	Max Number of Devices
170	10
200	100
220	200

The Group ID and Device ID should not be modified except under exceptional circumstances. One such circumstance would be operating two or more independent PowerMonitor W250 networks in such close proximity that RF interference with each other occurs. Please contact Rockwell Automation support services for more information or if assistance is required.

PC Receiver Connection

This section describes the RS-232 and RS-485 connections.

RS-232 Data Port Use and Configuration

DB-9 style connector: RS-232 Data Port connector with standard DCE connections for transmit data, receive data, RTS input, and CTS output.

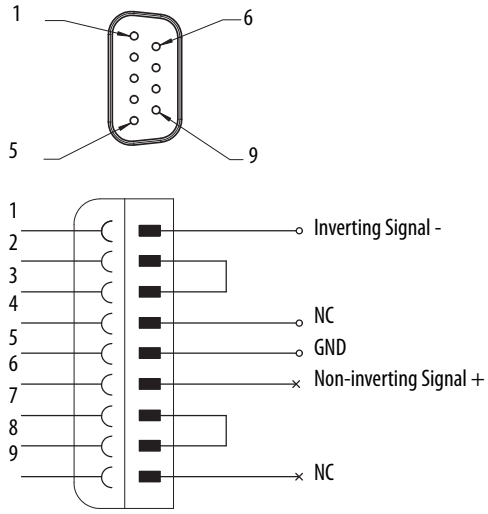
The PC Receiver is factory configured with the following parameters:

- Communication Rate - 115,200
- Data Bits - 8
- Parity - None
- Stop Bits - 1

PC Receiver RS-485 Data Port Use and Configuration

The RS-485 mode of the PC Receiver requires special wiring for the DB9 connection. In order to activate the RS-485 mode, please connect the data port as follows.

Figure 25 - PC Receiver RS-485 Wiring Diagram



As soon as the PC Receiver is powered on, it will choose the serial mode RS-232 or RS-485 according to the DB9 wiring. This mode will remain until the PC Receiver will be power cycled (removing the DB9 connector will have no effect).

RS-485 mode is available on the PC Receiver unit with the date code 10267 or later with firmware revision (or later) 1.5.15 (100 and 200 node) or 1.7.5.15 (10 node). Upgrade of an older PC Receiver (before date code 10267) is not possible, as it is a different hardware revision.

RS-485 mode sets the device Modbus address to 247. The address may not be changed. Only point-to-point communication is supported.

Software Interface

Introduction

This chapter describes the parameters and the registers available for software development. Data is presented using Modbus RTU protocol in Holding Registers. Modbus register addresses listed in these tables are zero-based. Modbus client applications may require that you add a constant value such as 40,000 to the Modbus register address. RSEnergyMetrix software uses the basic zero-based register addressing scheme.

PowerMonitor W250 Modbus Register Table

The following table reports Modbus registers specific to PowerMonitor W250 products.

Table 14 - PowerMonitor W250 Modbus Register Map

Modbus Register	Description	Type/Length	Storage	Unit	Access
0	Real Energy Consumption, Phase 1 MSW	S32	NV	Wh	R
1	Real Energy Consumption, Phase 1 LSW		NV	Wh	R
2	Real Energy Consumption, Phase 2 MSW	S32	NV	Wh	R
3	Real Energy Consumption, Phase 2 LSW		NV	Wh	R
4	Real Energy Consumption, Phase 3 MSW	S32	NV	Wh	R
5	Real Energy Consumption, Phase 3 LSW		NV	Wh	R
6	Real Energy Consumption, Phase Sum MSW	S32	NV	Wh	R
7	Real Energy Consumption, Phase Sum LSW		NV	Wh	R
8	Reactive Energy Consumption, Phase 1 MSW	S32	NV	VARh	R
9	Reactive Energy Consumption, Phase 1 LSW		NV	VARh	R
10	Reactive Energy Consumption, Phase 2 MSW	S32	NV	VARh	R
11	Reactive Energy Consumption, Phase 2 LSW		NV	VARh	R
12	Reactive Energy Consumption, Phase 3 MSW	S32	NV	VARh	R
13	Reactive Energy Consumption, Phase 3 LSW		NV	VARh	R
14	Reactive Energy Consumption, Phase Sum MSW	S32	NV	VARh	R
15	Reactive Energy Consumption, Phase Sum LSW		NV	VARh	R
16	Apparent Energy Consumption, Phase 1 MSW	U32	NV	VAh	R
17	Apparent Energy Consumption, Phase 1 LSW		NV	VAh	R
18	Apparent Energy Consumption, Phase 2 MSW	U32	NV	VAh	R
19	Apparent Energy Consumption, Phase 2 LSW		NV	VAh	R
20	Apparent Energy Consumption, Phase 3 MSW	U32	NV	VAh	R
21	Apparent Energy Consumption, Phase 3 LSW		NV	VAh	R

Table 14 - PowerMonitor W250 Modbus Register Map

Modbus Register	Description	Type/Length	Storage	Unit	Access
22	Apparent Energy Consumption, Phase Sum MSW	U32	NV	VAh	R
23	Apparent Energy Consumption, Phase Sum LSW		NV	VAh	R
24	Energy Counter Timestamp, Min / Sec	U16	V	R	
25	Energy Counter Timestamp, Day / Hour	U16	V	R	
26	Energy Counter Timestamp, Year / Month	U16	V	R	
27	Line Frequency	U16	V	Hz	R
28	Recording Interval Timestamp, Min / Sec	U16	V	R	
29	Recording Interval Timestamp, Day / Hour	U16	V	R	
30	Recording Interval Timestamp, Year / Month	U16	V	R	
31	Recording Interval Real Energy, Phase 1	S16	V	Wh	R
32	Recording Interval Real Energy, Phase 2	S16	V	Wh	R
33	Recording Interval Real Energy, Phase 3	S16	V	Wh	R
34	Recording Interval Real Energy, Phase Sum	S16	V	Wh	R
35	Recording Interval Reactive Energy, Phase 1	S16	V	VARh	R
36	Recording Interval Reactive Energy, Phase 2	S16	V	VARh	R
37	Recording Interval Reactive Energy, Phase 3	S16	V	VARh	R
38	Recording Interval Reactive Energy, Phase Sum	S16	V	VARh	R
39	Recording Interval Apparent Energy, Phase 1	U16	V	VAh	R
40	Recording Interval Apparent Energy, Phase 2	U16	V	VAh	R
41	Recording Interval Apparent Energy, Phase 3	U16	V	VAh	R
42	Recording Interval Apparent Energy, Phase Sum	U16	V	VAh	R
43	Maximum Current in Interval, Phase 1	U16	V	A	R
44	Maximum Current in Interval, Phase 2	U16	V	A	R
45	Maximum Current in Interval, Phase 3	U16	V	A	R
46	Minimum Voltage in Interval, Phase 1	U16	V	V	R
47	Minimum Voltage in Interval, Phase 2	U16	V	V	R
48	Minimum Voltage in Interval, Phase 3	U16	V	V	R
49	PowerMonitor W250 models Configuration (current range, connection diagram)	U16	NV	R	
50	Software Version (bits 8…15) Software Revision (bits 0…7)	U16	NV	R	
51	Status Word	U16	NV	R	
52	Command Word	U16	V	R/W	
53	Recording Interval Time Setting	U16	NV	min	R/W
70	Zero Power Detection	U16	NV	LSB	R/W

Table 15 - Information for Table 14

Term	Description	Comments
NV	Non-volatile	Value is restored after a power cycle
V	Volatile	Value is not restored after a power cycle
S16	Signed 16-bit INT	Range -32,768…32767
U16	Unsigned 16-bit INT	Range 0…65,535
S32	Signed 32-bit INT	Range -2,147,483,648…2,147,483,647
U32	Unsigned 32-bit INT	Range 0…4,294,967,297
MSW	Most Significant Word	
LSW	Least Significant Word	

Comments on PowerMonitor W250 Modbus Register Tables

The following sections provide comments on the Modbus register tables.

Energy Usage Data (Register 0…23)

These registers contain the raw, unscaled total consumed energy measured by the PowerMonitor W250 unit. The scaling factors listed in the next section must be applied to obtain energy values in the applicable engineering units of wH, VARh, and VAh. The energy counter time-stamp indicates when the data is sent to the gateway.

Energy usage data increments positive for energy consumed and negative for energy generated.

Real, reactive, and apparent energy consumption values are stored as 32-bit integer values using two Modbus registers. The lower register address contains the high (most significant) word (MSW), the higher register contains the low (least significant) word value (LSW).

See Scaling Factors for information on scaling the raw energy values in these registers.

Table 16 - Energy Counters

0, 2, …22	1, 3, …23
MSW	LSW

Scaling Factors

To obtain correct metering results, divide the raw values obtained from the listed Modbus registers by the applicable scaling factor from Table 17 and Table 18.

Table 17 - For All PowerMonitor W250 Models Except -480 Models with External 24V DC Control Power (up to 300V AC rms)

Current Range	100 A	200 A	500 A	1000 A	2000 A
Real Energy Wh [Intvl]	3.2	1.6	0.64	0.32	0.16
Real Energy Wh [Counter]	0.4	0.2	0.08	0.04	0.02
Reactive Energy VARh [Intvl]	3.2	1.6	0.64	0.32	0.16
Reactive Energy VARh [Counter]	0.4	0.2	0.08	0.04	0.02
Apparent Energy VAh [Intvl]	3.2	1.6	0.64	0.32	0.16
Apparent Energy VAh [Counter]	0.4	0.2	0.08	0.04	0.02
Volts rms	25	25	25	25	25
Amperes rms	60	30	12	6	3
Frequency, Hz	16	16	16	16	16

Table 18 - For PowerMonitor W250 Models Ending in -480 (24V DC powered)

Current Range	100 A	500 A	2000 A
Real Energy Wh (Interval)	1.6	0.32	0.08
Real Energy Wh (Counter)	0.2	0.04	0.01
Reactive Energy VARh Interval	1.6	0.32	0.08
Reactive Energy VARh (Counter)	0.2	0.04	0.01
Apparent Energy VAh (Interval)	1.6	0.32	0.08
Apparent Energy VAh (Counter)	0.2	0.04	0.01
Voltage, rms	12	12	12
Amperes, rms	60	12	3
Frequency, Hz	16	16	16

Energy and Recording Interval Time Stamps

The energy counter time stamp, read from Modbus registers 24...26 and the recording interval data time stamp, read from registers 28...29, are organized as shown in Table 19.

Table 19 - Time Stamp Data Syntax

Register		High Byte	Low Byte
24	28	Minute	Second
25	29	Day	Hour
26	30	Year	Month

Frequency (register 27)

The line frequency is measured on phase 1 of the line voltage. The most recent value measured within the recording interval is kept in this register.

Interval Energy Usage Data (Register 28 . . . 48)

Energy is integrated over a user-selectable recording time interval. Refer to Recording Interval Time (Register 53).

The interval energy usage values are calculated over the recording interval. At the end of each recording interval, the values are stored in the interval energy registers. The recording interval timestamp indicates the time at the end of the recording interval.

Interval real and reactive energy values are expressed in a signed 16-bit INT register with a raw value range of -32,768...32,767. Interval apparent energy values are similarly expressed in an unsigned INT with a raw value range of 0...65,535. The raw value is the value before the scaling factor is applied.

With certain combinations of load and interval time, the interval energy may exceed the range of the registers. In this case the registers will roll over (like a car odometer) and report incorrect interval energy. The tables below list calculated interval energy register raw values at various percentages of nominal phase current (Ipn) and nominal voltage for the particular power monitor model (240V or 480V) and 100% power factor. Values in bold font in the tables indicate where a value rollover is likely to occur.

We recommend that you adjust the interval to a shorter time period to avoid this issue.

Table 20 lists real or reactive energy values (one phase/sum of phases) at varying percent of nominal phase currents with nominal voltage 240V or 480V for SP2 model and 100% power factor (0% power factor for reactive energy).

Table 20 - Real or Reactive Interval Energy Raw Values

Load Current / **Interval Time (min)**	**25% Ipn**	**50% Ipn**	**100% Ipn**	**120% Ipn**
5	1600 / 4800	3200 / 9600	6400 / 19200	7680 /23,040
6	1920 / 5760	3840 / 11,520	7680 / 23,040	9216 /27,648
10	3200 / 9600	6400 / 19,200	12,800 / **38,400**	15,360 / **46,080**
12	3840 / 11,520	7680 / 23,040	15,360 / **46,080**	18,432 / **55,296**
15	4800 / 14,400	9600 / 28,800	19,200 / **57,600**	23,040 / **69,120**
20	6400 / 19,200	12,800 / **38,400**	25,600 / **76,800**	30,720 / **92,160**
30	9600 / 28,800	19,200 / **5,7600**	**38,400 / 115,200**	**46,080 / 138,240**

Table 21 lists apparent energy raw values (one phase/sum of phases) at varying percent of nominal phase currents with nominal voltage 240V or 480V for SP2 model.

Table 21 - Apparent Energy Raw Values

Load Current Interval Time (min)	25% Ipn	50% Ipn	100% Ipn	120% Ipn
5	1600 / 4800	3200 / 9600	6400 / 19,200	7680 /23,040
6	1920 / 5760	3840 / 11,520	7680 / 23,040	9216 /27,648
10	3200 / 9600	6400 / 19,200	12,800 / 38,400	15,360 / 46,080
12	3840 / 11,520	7680 / 23,040	15,360 / 46,080	18,432 / 55,296
15	4800 / 14,400	9600 / 28,800	19,200 / 57,600	23,040 / **69,120**
20	6400 / 19,200	12,800 / 38,400	25,600 / **76,800**	30,720 / **92,160**
30	9600 / 28,800	19,200 / 57,600	38,400 / **115,200**	46,080 / **138,240**

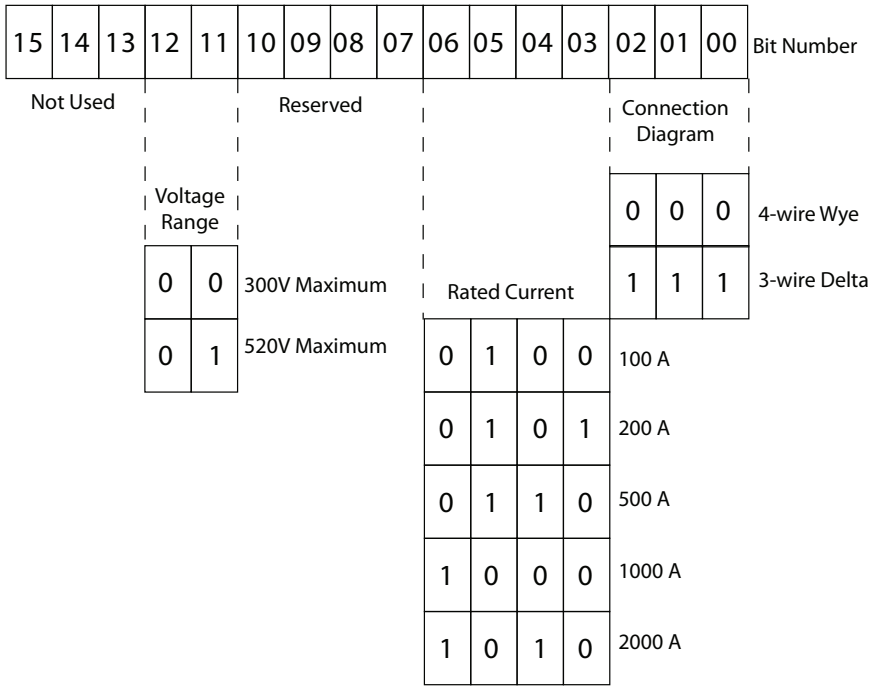
Maximum Current (register 43…45)

The rms current is averaged over 10 cycles (200 mS in a 50 Hz system, 167 ms in a 60 Hz system). The maximum average current in each phase, measured during the recording interval, is kept in registers 43...45.

Minimum Voltage (register 46…48)

The rms voltage for each phase is averaged over 10 cycles. The minimum voltage value measured during the recording interval is kept in registers 46...48.

Model Configuration (register 49)



Firmware Revision (register 50)

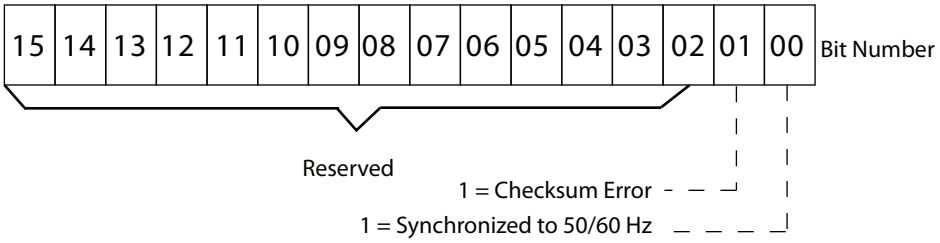
The firmware revision reflects the major release number of the PowerMonitor W250 firmware.

The high byte of this register contains the version number.

The low byte of this register contains the revision number.

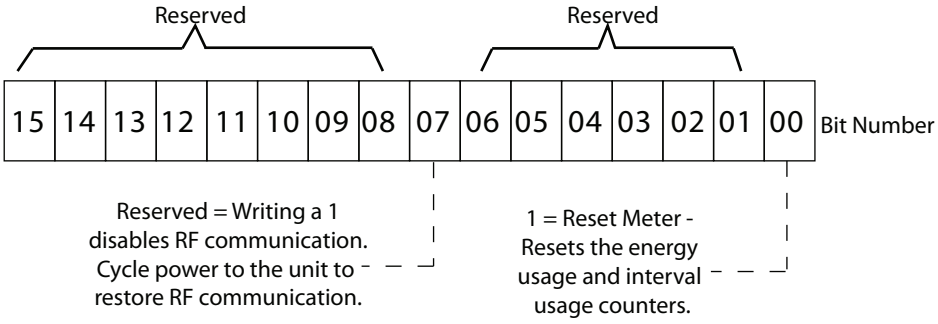
Status Word (register 51)

The Status Word indicates through a bit map the status items shown in the diagram.



Command Word (register 52)

The PowerMonitor W250 unit is able to execute commands after a write to a command word, which is mapped to a read/write register. Setting a bit in the command word executes the command.



Reset Meter

This command resets the energy counters to zero in both RAM and nonvolatile RAM. This command does not affect the reporting interval values.

Recording Interval Time (Register 53)

The recording interval time is a configurable parameter that defines the recording interval in minutes.

It can take the values 5, 6, 10, 12, 15, 20, 30.

The start of such an interval is at the hour + n* interval.

When writing a value other than the ones listed to this parameter, it will be discarded and the PowerMonitor W250 unit will continue to use the previous set value.

Note that the PC Receiver will respond with an 'ACK' to a write of a valid or non-valid value as it does not check the contents of the message sent to the PowerMonitor W250 unit.

IMPORTANT When changing the interval time, the PowerMonitor W250 unit will calculate the end of the next recording interval time while keeping the current interval measurements. This means that at the end of the recording interval, the timestamp will be correct with respect to the new setting, but the first interval values are not guaranteed to be integrated over the set interval time and thus should be discarded by the master application software.

Zero Power Detection (register 70)

This register defines a Zero Power Multiplier integer value between 0...10, with a default value of 3. The formula below utilizes this value to define a Zero Power Threshold, below which the power monitor will consider the value as zero. A value of less than 3 for the multiplier is not recommended.

The Zero Power Threshold level expressed in watts, is then:

(Zero Power Multiplier * 8.8) / Interval Energy Scaling Factor.

For instance, considering a PowerMonitor W250-100 device.

Zero power threshold = 3 * 8.8 / 3.2 = 8.25 watts.

When the measured value of power is less than the zero power threshold, Real, Reactive, and Apparent Energy registers do not increment, and the Maximum Current registers are set to 0.

RF Communication Configuration and Status Modbus Register Table

This table lists the common registers used by all devices (power monitors, routers, and PC receiver).

Table 22 - RF Communication Configuration and Status

Modbus Register	Description	Type/Length	Storage	Unit	Access
201	Hop count	U16	V		R
202	First hop ID	U16	V		R
203	Last hop ID	U16	V		R
204	RSSI (high byte) and Supply voltage (low byte)	U16	V		R
220	Device ID (high byte and low byte)	U16	NV		R
221	Group ID (high byte and low byte)	U16	NV		R
222	Sampling interval	U16	NV		R
224	Network channel (11…26)	U16	NV		R
347	Device ID (high byte and low byte)	U16	NV		See warning below
348	Group ID (high byte and low byte)	U16	NV		See warning below
349	Sampling interval	U16	V		W
351	Network channel (11…26)	U16	NV		W

WARNING: Do not change the value of the Device ID or Group ID, registers 347 and 348. Doing so will cause the device to drop off the network and require factory service to restore operation.

Table 23 - Information for Table 22

Term	Description	Comments
NV	Nonvolatile	Value is restored after a power cycle
V	Volatile	Value is not restored after a power cycle
U16	Unsigned 16-bit INT	Range 0…65,535
High byte	Bits 8…15	
Low byte	Bits 0…7	

Comments on RF Communication Configuration and Status

The following sections provide comments on the RF communication configuration and status tables.

Hop Count (register 201)

This register reports the number of network node hops taken by a packet delivered from the device to the PC Receiver. A device with a hop count equal to 1 is communicating directly with the PC Receiver.

For hop counts greater than 1, the First Hop ID (register 202) and the Last Hop ID (register 203) report the device ID of respectively the first Router and the last Router on the path used by a packet to get to the PC Receiver.

Radio Signal Strength Indicator, RSSI (register 204)

RSSI value is stored in the high byte of Register 204 and can be either positive or negative (signed integer).

When negative, the value is expressed by using 2's complement. The following table shows some examples of RSSI representation and the significance of the values.

Table 24 - RSSI Register 204

RSSI Value	Register 204 Low Byte in Decimal (hex)	Signal Strength Category
≥-20	236 (0xEC)	Strong
-20…-35	236 (0xEC)…221 (0xDD)	Good
-35…-45	221 (0xD)…211 (0xD3)	Weak
< -45	211 (0xD3)	Not acceptable

The second byte of register 204 is the battery voltage raw data, which can be converted into voltage value in decimal as follows:

Battery Voltage = (1.225*1023.0)/(blRaw+344)

where blRaw is the raw value in decimal. For instance, a battery reading of 0x19 (2nd byte of register 204) would be 25 in decimal, then Battery Voltage = (1.225*1023) / (25+344) = 3.3961V.

Device and Group ID

Device ID and Group ID can be directly read respectively in registers 220 and 221. They can be modified by registers 347 (Device ID) and 348 (Group ID).

ATTENTION: The Group ID and Device ID should not be modified except under exceptional circumstances. One such circumstance would be operating two or more independent PowerMonitor W250 networks in such close proximity that RF interference with each other occurs. Please contact Rockwell Automation support services for more information or if assistance is required.

Network Channel

The Network Channel can be read in register 224 and overwritten into register 351 by any value between 11 and 26.

IMPORTANT The Network Channel should not be modified except where interference with other RF communication occurs. Please contact Rockwell Automation support services for more information or if assistance is required.

ATTENTION: Modifying the Network Channel may result in loss of communication between the device and the network. This will require return of the device to Rockwell Automation for factory service.

Sampling Interval

This interval time is the maximum period for a heartbeat to be sent by any node, when no data is transmitted within that period, in order to indicate that the device is still online. The sampling interval is expressed in tenths of seconds from 0...65,535 (65,535 = 109 minutes), read from register 222 and written into register 349.

The PowerMonitor W250 unit uses a default value of 30 s (value 300).

PC Receiver Modbus Registers

These registers hold information about the PC Receiver and the wireless network.

Table 25 - PC Receiver Register Table

Modbus Register	Description	Storage	Type	Read/Write
0	Group ID	V	U16	R
1	PC Receiver device ID	V	U16	R
2…17	Online device ID list bitmap (including the PC Receiver ID)	V	U16	R
18	Total online device count	V	U16	R
19…20	Network UTC time	V	U16	R/W
37	PC Receiver firmware version major number	V	U16	R
38	PC Receiver firmware version minor number	V	U16	R
39	PC Receiver firmware version revision number	V	U16	R
40…44	Reserved for future use	V	U16	
45	Radio channel number (11…26)	V	U16	R/W

Comments on PC Receiver Register Table

The following sections provide comments on the PC receiver register table.

Active End Node List (registers 2…17)

Table 26 - Online Device Matrix

Register	Device Modbus Address / 1 = Active, 0 = Inactive															
Bit #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	240	241	242	243	244	245	246	247	-	-	-	-	-	-	-	-
3	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
4	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
5	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
6	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
7	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
8	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
9	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
10	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
11	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
12	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
13	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
14	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
15	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
17	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Each bit of the 16 registers corresponds to a Modbus slave address. The Modbus address is mapped to bit number as follows:

Examples:

- PowerMonitor W250 N° 25: register 16, bit 9 = 1
- PowerMonitor W250 N°16: register 16, bit 0 = 1

PC Receiver Network Channel (register 45)

IMPORTANT As already stated, the Network Channel should not be modified except where interference with other RF communication occurs. Please contact Rockwell Automation support services for more information or if assistance is required.

The PC Receiver indicates and permits changing the channel number through this ModBus register.

If you decide to change this parameter in the PC Receiver, the routers and end devices (power monitors) will then scan for the PC Receiver and synchronize on the same channel. The process of synchronizing may take several minutes.

ATTENTION: Before changing the channel number of a network, power down all devices in any other PowerMonitor W250 network within radio range, to prevent devices from the other network from synchronizing their channel to the incorrect PC Receiver.

PC Receiver Network UTC Time (registers 19…20)

The PC Receiver stores the reference time for the entire network in these registers. Registers: 19 (MSW) and 20 (LSW) concatenate to form a 32-bit UTC value. The value is equal to the number of seconds elapsed since January 1, 1970.

Routers and PowerMonitor W250 units will synchronize their internal real time clocks after powerup, and thereafter at periodic intervals (2...4 minutes).

The initial synchronisation can take up to 6 minutes, depending on the network configuration/number of hops from the PC Receiver to the PowerMonitor W250 units.

The PC Receiver is not equipped with a battery, so the internal time is not kept when power is removed. It is thus necessary to set the PC Receiver time immediately after powerup.

Since time drift can be up to several seconds per day, synchronizing the PC Receiver's time periodically with the Master application's time is necessary.

IMPORTANT When setting the time in the PC Receiver, both UTC registers need to be written in one command.

The ongoing recording intervals in the PowerMonitor W250 units will be disrupted by a change of the PC Receiver time.

Modbus Command Interface

The Wireless Mesh Network communicates with client devices by using the Modbus RTU protocol. Modbus ASCII is not supported. Please refer to the Modbus Application Protocol Specification, v1.1b, December 28, 2006, available from http://www.modbus.org.

IMPORTANT ASCII mode is not supported.

A client application acting as a Modbus RTU Master communicates through the PC Receiver to obtain data (and issue commands) to end devices (power monitors) in the wireless network. The PC Receiver may be directly addressed by using Modbus address 247.

In this mode, the following commands are supported:

- Read Holding Registers (0x03)
- Write Multiple Registers (0x10)
- Read Device Identification (0x2B/0x0E)

The PC Receiver also acts as a proxy for the power monitors in the network. As described earlier, the power monitors periodically broadcast data to the PC Receiver. The PC Receiver in turn buffers the data and responds to commands issued by the Modbus Master that are addressed to the power monitors. Available Modbus commands are:

- Read Holding Registers (0x03)
- Write Multiple Registers (0x10)

IMPORTANT Response of a write command will always be an 'acknowledge' response.To verify if a write command is successful, poll the register that it was written to.

The PC Receiver will respond to a write command with an 'acknowledge' exception code 0x05. This indicates the server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a time-out error from occurring in the client (or master). The client (or master) can next issue a Poll Program Complete message to determine if processing is completed. (From the Modbus Application Protocol Specification, v. 1.1b, December 28, 2006.)

Network Identification of PowerMonitor W250

Each of the PowerMonitor W250 units has a unique 16-bit Device ID, which is printed on the label in the form of [High Byte].[Low Byte].

The low byte of the Device ID is the device Modbus address.

Modbus Communication Reference

The PowerMonitor W250 units are seen as Modbus slaves through the PC Receiver. The maximum size of a Modbus RTU frame is 256 bytes. A Modbus request has the following general format.

Table 27 - Modbus Request Format

Description	Slave Address	Function Code	Request Data	CRC
Byte Count	1	1	4 (typical, see below)	2 (LSB | MSB)

Read Holding Registers (Function code 0x03)

Table 28 - Master Request Format

Description	Slave Address	Function Code	Request Data	CRC
Hex	0xID	0x03	0xXX . . . 0x7D	0xLSB 0xMSB

Table 29 - Slave Request Format

Description	Slave Address	Function Code	Request Data	CRC
Hex	0xID	0x03	0xXX 0xYY	0xLSB 0xMSB

The following is a Modbus master read request packet. A request is referred to as a packet sent from the Modbus master application to the gateway slave. This has a function code value of 0x03, Read Holding Registers.

The Request Data includes a 2-byte starting address offset value and a 2-byte length value specifying the length of data to be returned in a 16-bit word (number of Holding Registers, 1...125 (0x7D).

Examples

Read the frequency from the PowerMonitor W250 with Modbus address 63:

- Modbus address - 0x3F
- Starting register - 0x1B (register 27 decimal)
- Length - 0x01

[3F 03 00 1B 00 01 F0 D3]

Read all current and voltage values from the PowerMonitor W250 with Modbus address 63:

- Modbus address - 0x3F
- Starting register - 0x2B (register 43 decimal)
- Length - 0x06

[3F 03 00 2B 00 06 B1 1E]

Certifications

UL

The power monitors are certified by UL to the following standards: UL 61010-1 and CSA C22.2 No. 61010-1.

European Communities (EC) Directive Compliance

CE

If this product has the CE mark, it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

- Low Voltage Directive (2006/95/EC)
- R&TTE Directive (1999/5/EC)
- EMC Directive (2004/108/EC)

Refer to Additional Resources on page 5 for instructions on how to get a CE DoC for this product.

This equipment may be operated in AUT, BEL, BUL, CZE, CYP, DNK, EST, FIN, F, D, GRC, HNG, ISL, IRL, I, LVA, LIE, LTU, LUX, MLT, HOL, POL, POR, ROU, SVK, SVN, E, SUI, S, G, BIH, GEO, HRV, MDA, MKD, MNE, SRB, TUR.

The use of this equipment requires a license in NOR, RUS, UKR.

FCC, IC

PowerMonitor W250 units have the following approvals and certifications.

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. (15.21)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. (15.19)

IMPORTANT FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

- Industry Canada statement:

  This device complies with RSS-210 of the Industry Canada Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

Notes:

Specifications

General and Environmental Specifications

Table 30 - PowerMonitor W250, Line Powered up to 300V AC rms

Attribute	Value
Primary nominal current	20…2000 A (depending on the model)
Primary voltage, measuring range (neutral/phase) (VPN)	90…300V rms
Primary voltage, nom range (N/L) (VPN)	100…272V rms
Absolute min/max input voltage (N/L)	90 …300V rms
Frequency	50/60 Hz
Max power consumption	2 W
Max supply current (N-L1)	0.2 A rms
Ambient operating temperature (90% rH) (TA)	-10 …55 °C (14…131 °F)
For indoor use only	
Altitude	Up to 2000 m (6562 ft)
Protection degree	IP2X
Pollution degree	PD2
Isolation	Isolation class II IEC 61010-1 CAT III 300V RMS

Table 31 - PowerMonitor W250, External 24V DC Powered (-480 modes)

Attribute	Value
Primary nom current (IPN)	100…2000 A (depending on the model)
Primary voltage, measuring range (VPN)	180…520V rms
Frequency	50/60 Hz
External power supply (+/- 10%)(1)	24V DC
Max supply current	50 mA DC
Ambient operating temperature (90% rH) (TA)	-10…55 °C (14…131 °F)
For indoor use only	
Altitude	Up to 2000 m (6562 ft)
Protection degree	IP2X
Pollution degree	PD2
Isolation	Isolation class I IEC 61010-1 CAT III 300V RMS(1)

(1) The product must be connected to earth (ground).

Table 32 - Accuracy and Range

Parameter	Accuracy in % of Reading at 25 °C (77 °F) (50/60 Hz)	Nom/Range
Voltage	Min value in interval 1.5%	D3 model: 240V 3-wire Delta/ 90…300V AC line-to-line 277V line-to-neutral 4-wire WYE/ 90…300V AC line-to-neutral 480 models: 480V 3-wire Delta/ 90…520V AC line-to-line
Current	Max value in interval 1.5%	Depending on model, monitor load range 100…2000 A
Frequency	Based of Phase 1	50 or 60 Hz/ 45…66 Hz
Energy functions: kWH	IEC 62053-21 Class 1 ± 1%	
Energy functions: kVARH	IEC 62053-23 Class 3 ± 3%	
Metering update rate		kWh, kVarh, kVAh counters @ 1 minute; Interval Energy Data @ configurable 5, 6, 10, 12, 15, 20, or 30 minutes

Table 33 - Input and Output Ratings

Attribute	Value
Control power	100…277V rms AC at 50/60 Hz (line-to-neutral) 2 W max consumption 24V DC power for 480 models

Table 34 - General Specifications

Attribute		Value
Dielectric withstand	CT-based model	3500V
	Rogowski-based model	3500V
Terminal blocks		2.5 mm sq. for input voltage (18…24 AWG) 0.5 N•m (0.37 lb•ft)
Certifications		CE, cULus (power monitors only), FCC Part 15, Industry Canada RSS-210

Table 35 - General Environmental Specifications

Attribute	Value
Temperature, operating	-10…55 °C (14…131 °F)
Temperature, nonoperating	-25…70 °C (-13…158 °F)
Humidity	90% RH max
Mass	0.4 kg (0.88 lb)
Protection index	IP 2X
Standards	EN 50178: 1997
	EN 61010-1: 2001

Wireless Network Characteristics

- Radio standard - IEEE 802.15.4 (ISO/IEC 8802.15.4)
- Protocol - Proprietary
- RF Band - 2.4 GHz

Table 36 - RF Power Operating Range (line of sight)

Attribute	PC Receiver and Router	PowerMonitor W250
RF max power	100 mW (20 dBm)	10 mW (10 dBm)
Operating range between PowerMonitor W250 and PC Receiver or Router	30 m (95 ft)	-
Operating range between PC Receiver and Routers	228 m (750 ft)	-

Table 37 - Wireless Communication Operating Range (line-of-sight)

Attribute	Value
PC Receiver to Monitor	25 m (82 ft)
Monitor to Router	25 m (82 ft)
PC Receiver to Router	260 m (853 ft)

ATTENTION: The operating range could change depending on building configuration and network layout.

Notes:

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1.

RTC Real Time Clock

UTC Coordinated Universal Time. Number of seconds passed since 1.1.1970

PC Receiver Gateway device that controls the RF network and provides a serial interface for the customer

Router RF router/repeater

End Node RF communication module integrated in the PowerMonitor W250

Hop Count Number of network node hops taken by a packet delivered from a node to the PC Receiver

For example: End Node - PC Receiver = 1 hop,

End Node - Router - PC Receiver = 2 hops

(each additional Router will add another hop).

Modbus RTU Serial communication protocol used by the PC Receiver

SELV Safety Extra Low Voltage

Notes:

V

W

Z

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect[SM] support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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